SOME INTERESTING ASPECTS OF A SUBTROPICAL DEPRESSION MAY 18–28, 1958

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1. INTRODUCTION

During the period May 18–28, 1958 a subtropical depression formed in the Caribbean Sea and moved north-northeastward parallel to the east coast of the United States. The Low became extra-tropical and continued northward west of Greenland. This system had many interesting features. It gave heavy rains to the Miami area causing some local flooding. It had all the prospects of becoming a full scale hurricane but the winds never even reached storm speed (greater than 38 m. p. h.) until after the depression became extra-tropical. As this occurred the Low's vertical structure was peculiar. These points and others are discussed in this article.

2. ORIGIN OF DEPRESSION

The depression had its origin on the asymptote of an earlier vortex that originated on May 17, when Pacific air crossed over Panama at 0000 GMT. By 0000 GMT on the 18th the vortex was clearly fixed at San Andres near 13° 30′ N., 81° W.

The pibal from Maracaibo, Venezuela first showed westerly winds (at 6,000 to 7,000 ft.) at 1800 GMT on May 18, indicating the formation of a sink on the well-developed asymptote for the parent storm at San Andres. The original center was still near San Andres on May 19 with the new center, on the asymptote, clearly in evidence near Maracaibo. The 1200 GMT pibal from Maracaibo continued to show southwest winds at the top of the run, indicating the intensification of the vortex.

On May 20 at 0000 GMT, the new system began to revolve around the original vortex which was still located at San Andres. The new system continued to rotate on the 21st as it approached Jamaica, and by 0000 GMT on the 22d was nearing Grand Cayman, while the old center remained near San Andres. At 0000 GMT on May 23 the new center had become better organized and by 1200 GMT of that date a definite closed Low could be located at the surface at 20° N., 83° 30′ W. Thenceforth the depression slowly deepened and continued to move northward.

The Low formed over an area of warm water. Figure 2A shows that on May 21 the surface water temperatures

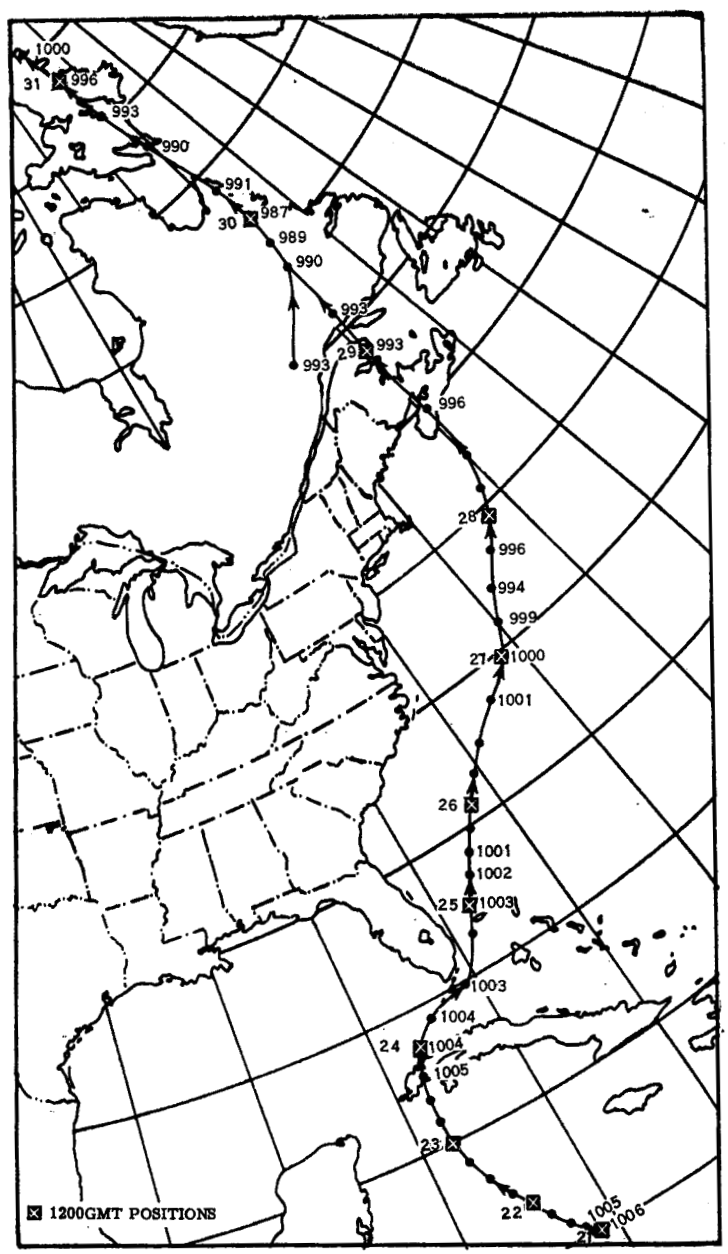

FIGURE 1.—Track of the depression including the track beyond the position when it became extra-tropical at 0000 GMT, May 27, 1958.

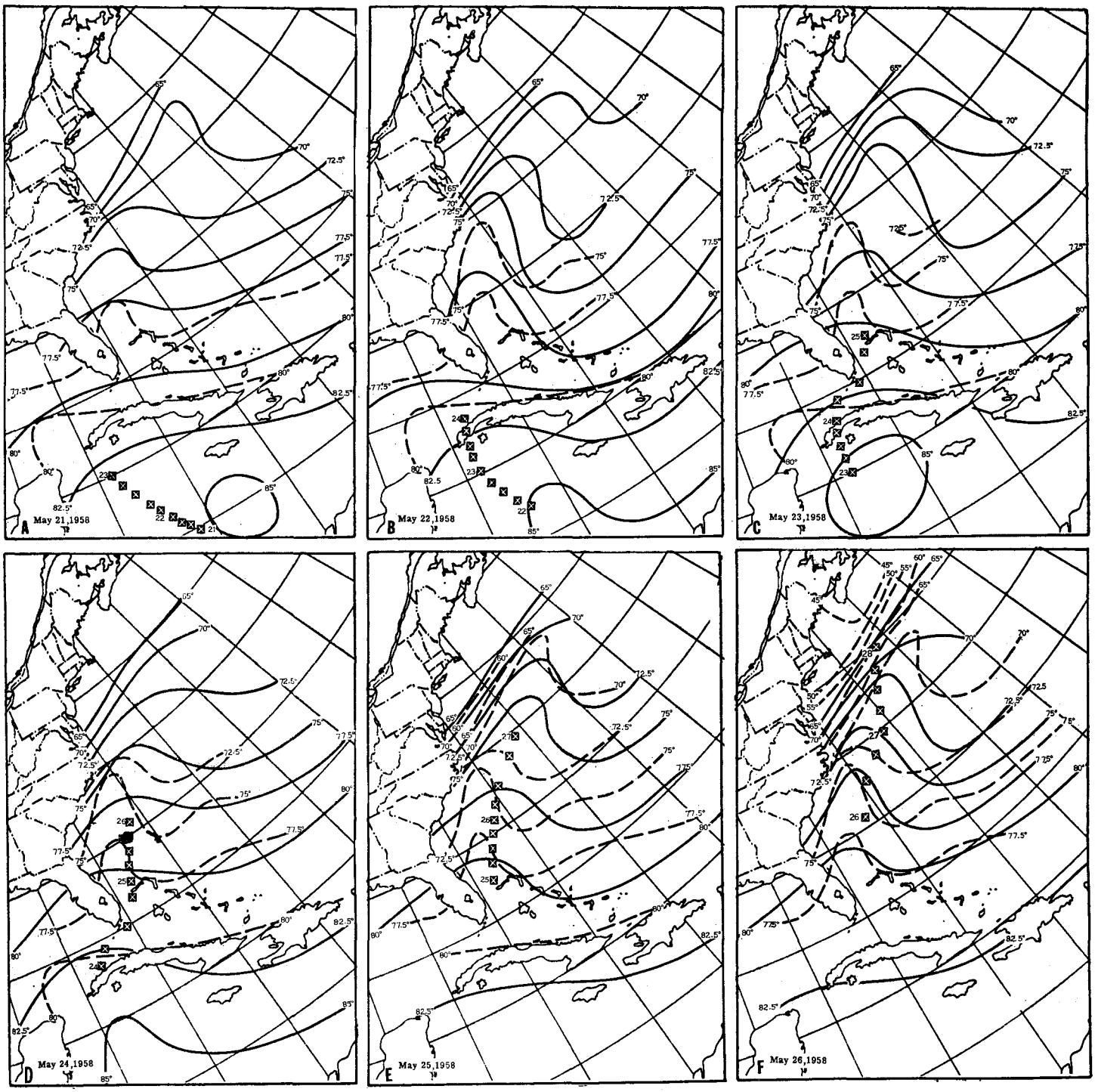

FIGURE 2.—Charts of the sea water temperature (solid lines) by days, for May 21–26. The normal sea water temperature for May is dashed. A portion of the storm track is superimposed to show the relationship between the direction of movement and the area of warm water.

were several degrees above normal in the area where the depression was forming.

3. TRACK OF DEPRESSION

After the circulation became well organized the depression moved northward and slightly eastward to a position at 24°30′ N., 82°30′ W. (fig. 1) by 1800 GMT, May 24. The system then took a more easterly direction as though trying to avoid the Florida peninsula or to follow the Gulf Stream between Cuba and Florida. After passing south of Florida the Low turned and began a northeasterly course on May 25.

As the depression moved northeastward it appeared to

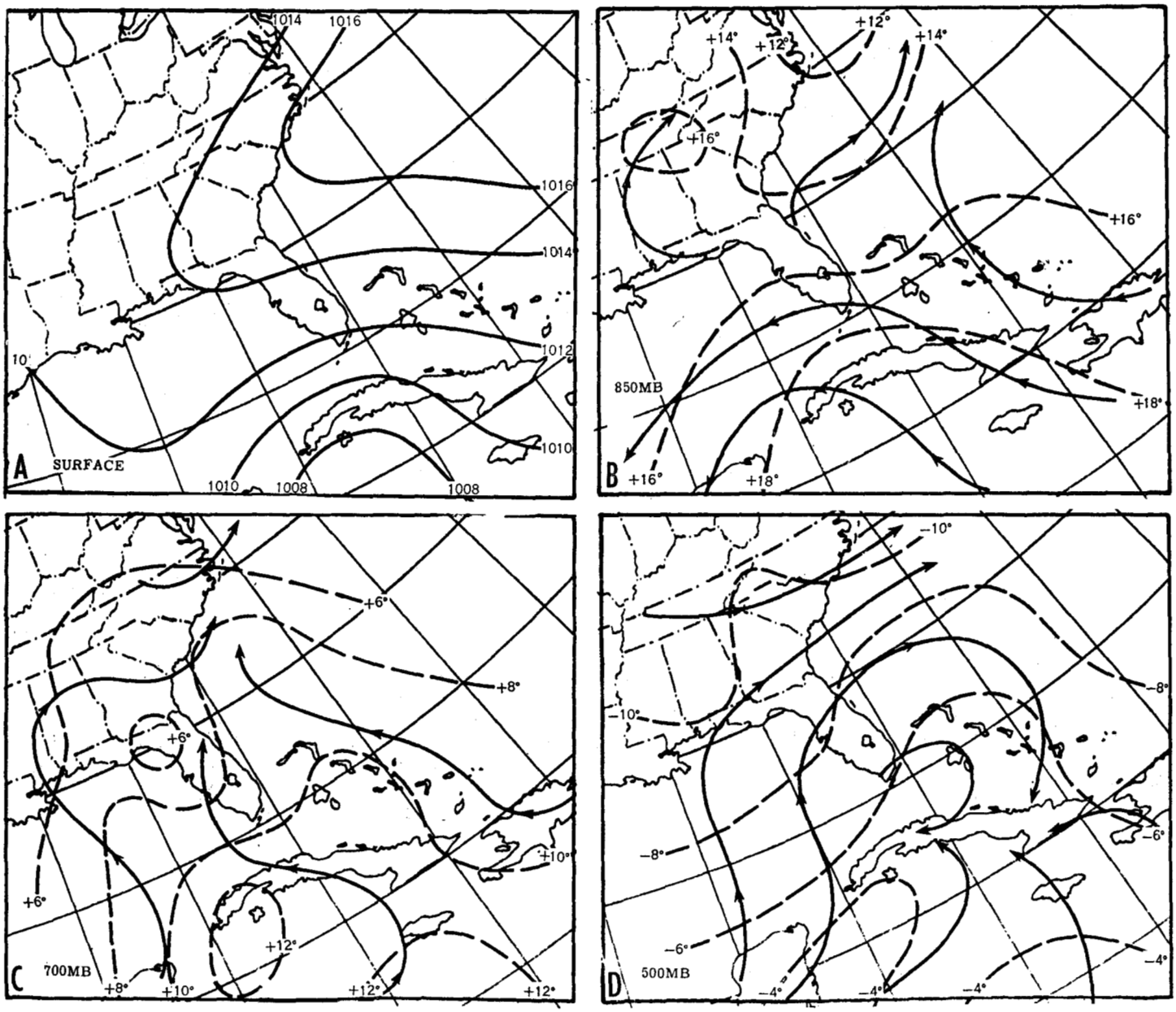

FIGURE 3.—0000 GMT, May 23, 1958. (A) Surface pressure, (B), (C), and (D) streamlines and isotherms at 850, 700, and 500 mb., respectively. These and the charts in figures 4 through 7 show the convergence in the Miami area and the limited extent of the depression in the upper-air flow.

follow the stream of warm water as shown by figure 2, where the track of the depression is superimposed on the surface water temperature charts as analyzed from ship reports. Reported water surface temperatures (solid lines in fig. 2) were above normal, consistent with the findings of Fisher [1]. The track shows that this depression continued to follow this warm stream of water through May 26.

4. PRECIPITATION IN THE MIAMI AREA

In a hurricane the northeast quadrant is expected to give the largest amounts of rainfall. While this depression never reached storm proportions the rainfall pattern fits the hurricane classification. When the depression was southwest of Miami the greatest area of convergence and curvature passed through Miami (figs. 3, 4, 5). This is evident on the 0000 GMT surface and 850-mb. charts of May 24 (fig. 4A, B). During the period of passage of the depression the total amounts of rainfall varied from 12.07 inches at Homestead, Fla. to 5.60 inches at Fort Lauderdale (fig. 8) with the greatest amounts concentrated in the Miami area. It can be concluded that the maximum curvature and convergence was concentrated in this location.

The upper-air soundings show almost complete saturation through 500 mb. for the 23d and 24th of May with

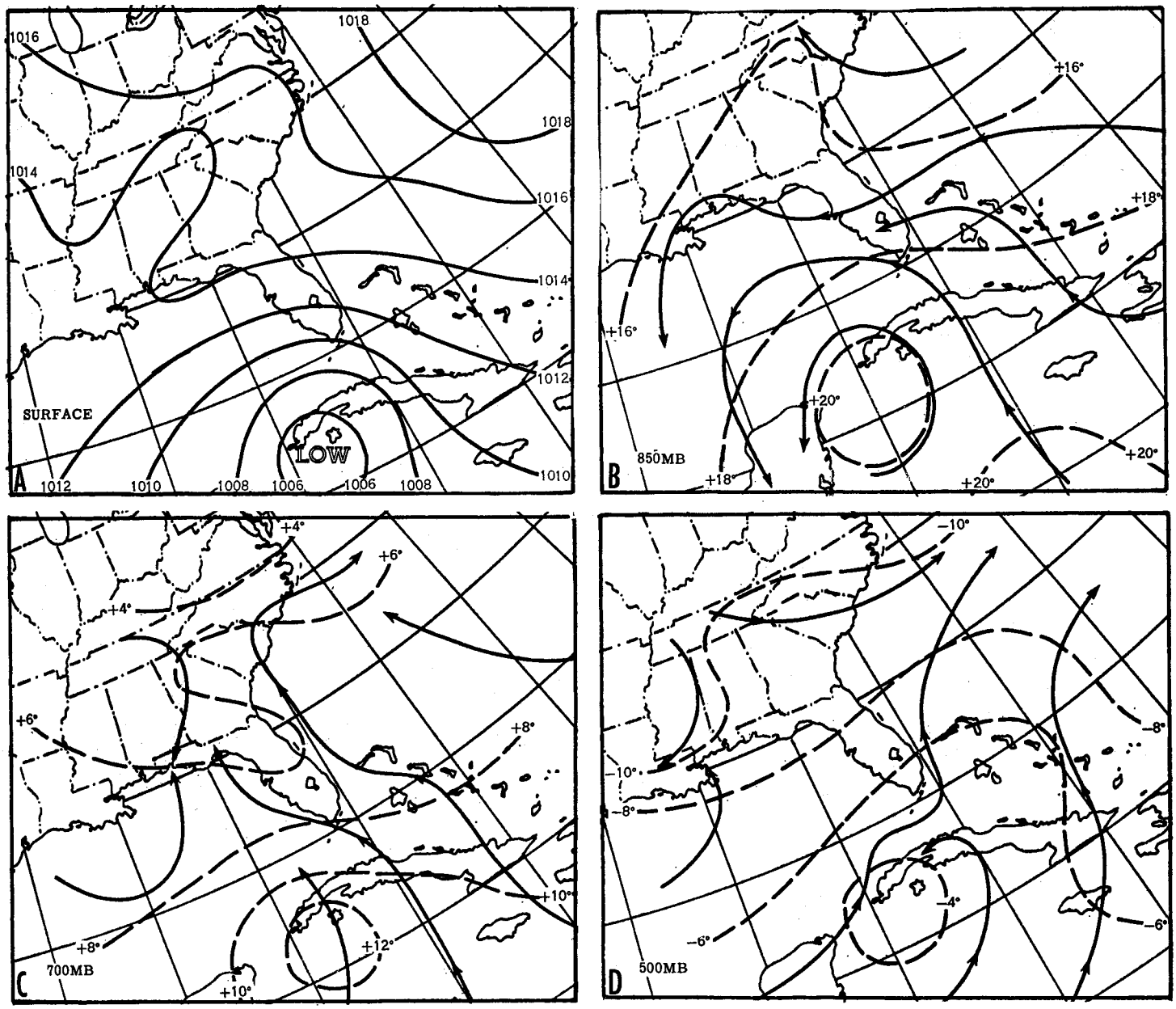

FIGURE 4.—0000 GMT, May 24, 1958. (A) Surface pressure, (B), (C), and (D) streamlines and isotherms for 850, 700, and 500 mb., respectively.

some drying out near 500 mb. at 1200 GMT, May 24 (fig. 9). The precipitable water values for these times were 1.65, 1.88, 1.80, and 1.57 inches, respectively. This compares with maximum precipitable water content of about 2.5 inches in hurricanes. As this area of convergence and curvature moved northeastward several island stations northeast and east of Miami reported large 6-hourly amounts of rainfall.

The rainfall of this system, when added to the rains of the month, gave WBO Miami 16.15 inches, the second wettest May since records began there in 1911 [2]. A total of 18.66 inches fell in 1925. Miami Airport recorded a monthly total of 18.14 inches, which was the greatest total fall for May during its 18 years of record. Miami Beach also broke its existing May record (since 1941) with a total fall of 11.70 inches. This period of heavy rain interrupted the harvesting of vegetables in Dade and Broward counties. Some crops showed a loss in production in the area of extremely heavy rains [3].

5. VERTICAL DEVELOPMENT

Throughout the Low's history as a depression its vertical structure never developed very much. As figures 3–7 show, while the Low deepened at the surface, the upper-air picture did not become well organized. Only during

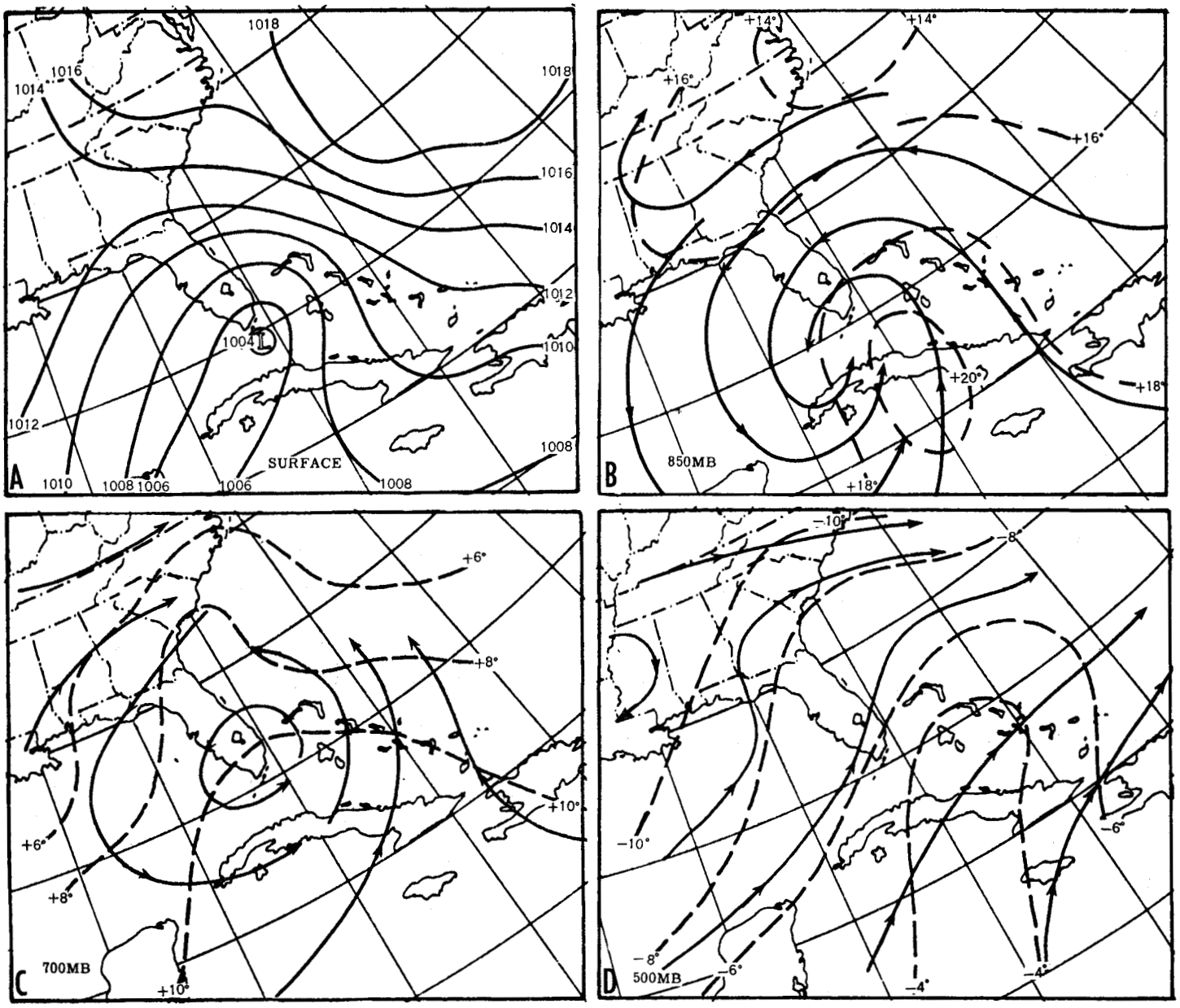

FIGURE 5.—0000 GMT, May 25, 1958. (A) Surface pressure, (B), (C), and (D) streamlines and isotherms for 850, 700, and 500 mb., respectively.

May 24, 25, and 26 did the Low build to any great height, and even on these days the structure developed only through the 700-mb. level, with the 500-mb. level never showing a closed circulation. Examination of the upper air through 200 mb. during the Low's history never shows any level of definite divergence.

Malkus [4] has set certain conditions for a depression to become a full grown hurricane. Although she refers to a depression formed on an easterly wave, it can be assumed that the requirements for development are applicable in this situation. This Low, although having a warm core, did not have the temperature discontinuity Malkus feels necessary for development. Without this temperature discontinuity or the more necessary upper-level divergence, this depression never reached the stage of forming an eye. The formation of an eye is referred to by Malkus as the point of no return.

Examination of the charts (fig. 5A, B) also shows some signs of a secondary circulation at the surface and at the 850-mb. level southwest of the main Low. This secondary Low may have robbed the primary system of enough energy to prohibit the main Low from becoming a major storm.

6. FORECASTING DIFFICULTIES

On May 26 the position and recent movement of the Low up the coast presented a forecasting problem as to its future movement. The forecaster who made the surface

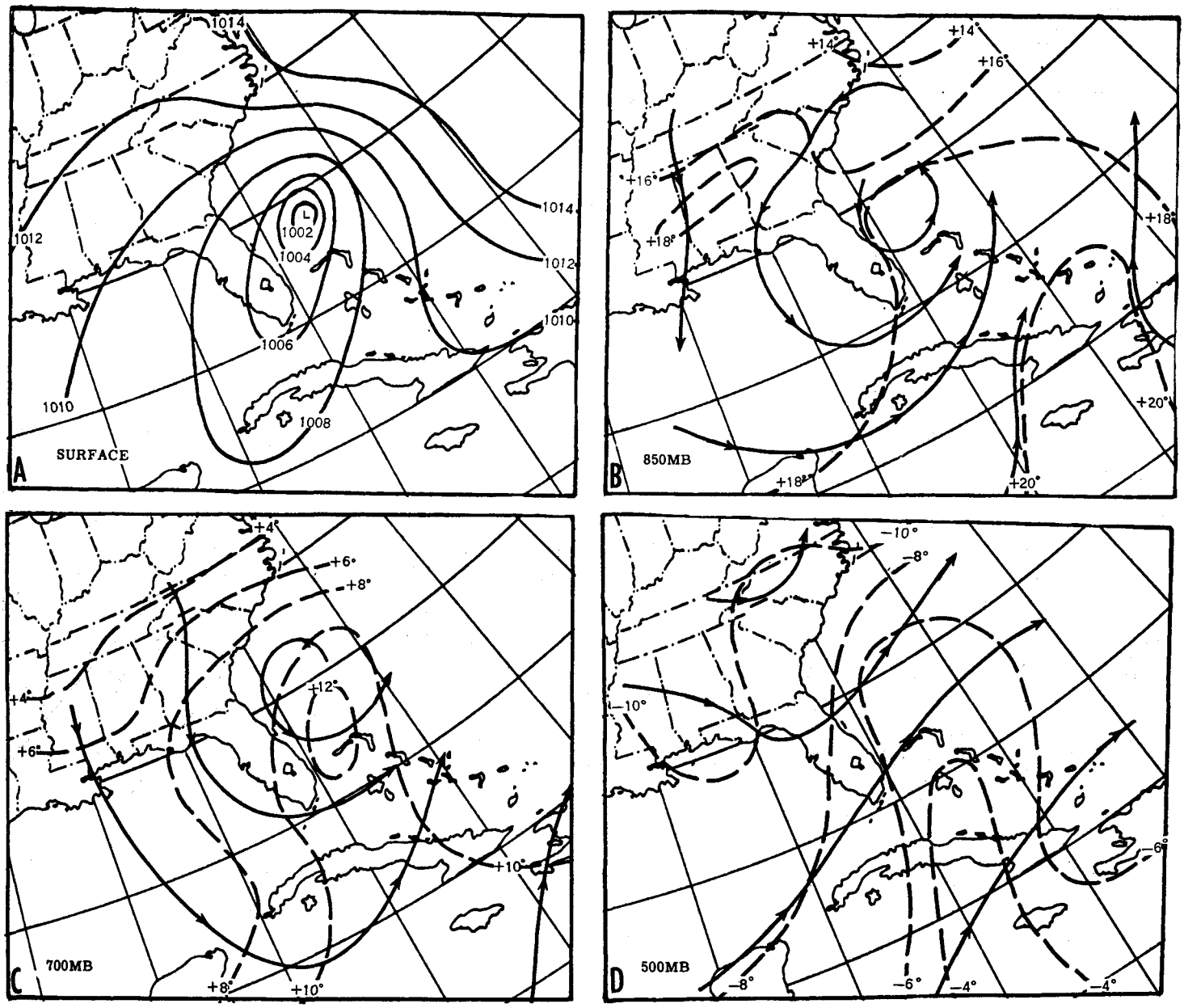

FIGURE 6.—0000 GMT, May 26, 1958. (A) Surface pressure, (B), (C), and (D) streamlines and isotherms at 850, 700, and 500 mb. respectively.

prognostic chart from the 1200 GMT chart used the 500-mb. flow to forecast the movement of the Low. This upper-air flow indicated the system would continue to move on its northeasterly course.

The succeeding forecaster had another problem to face. The surface High located over the eastern Great Lakes region appeared to be moving eastward across the path of the Low. Since the High appeared to be moving to the north or north-northeast of the current path of the Low, the forecaster expected the High to block the Low for a period of about 18 hours and force the system into a more northerly course. Using this reasoning the Low was forecast to hit the east coast near Wilmington, N. C. (fig. 10).

At the same time the District Forecaster at Washington, D. C., had used comparable reasoning to bring the Low to the coast. The District Forecast Office at Washington uses a rule in forecasting hurricanes and similar Lows, which briefly is as follows. When 12-hour pressure *rises* are in the path of a storm the Low will tend to turn to the left. Alternatively, when 12-hour pressure *falls* are in the path, the Low will tend to turn to the right. Using this forecast tool, the District Forecaster brought the storm into the coast and forecast cloudy skies with rain, the rain becoming heavy at times, for the coastal area from North Carolina to New England.

However, as sound as the reasoning was, these events

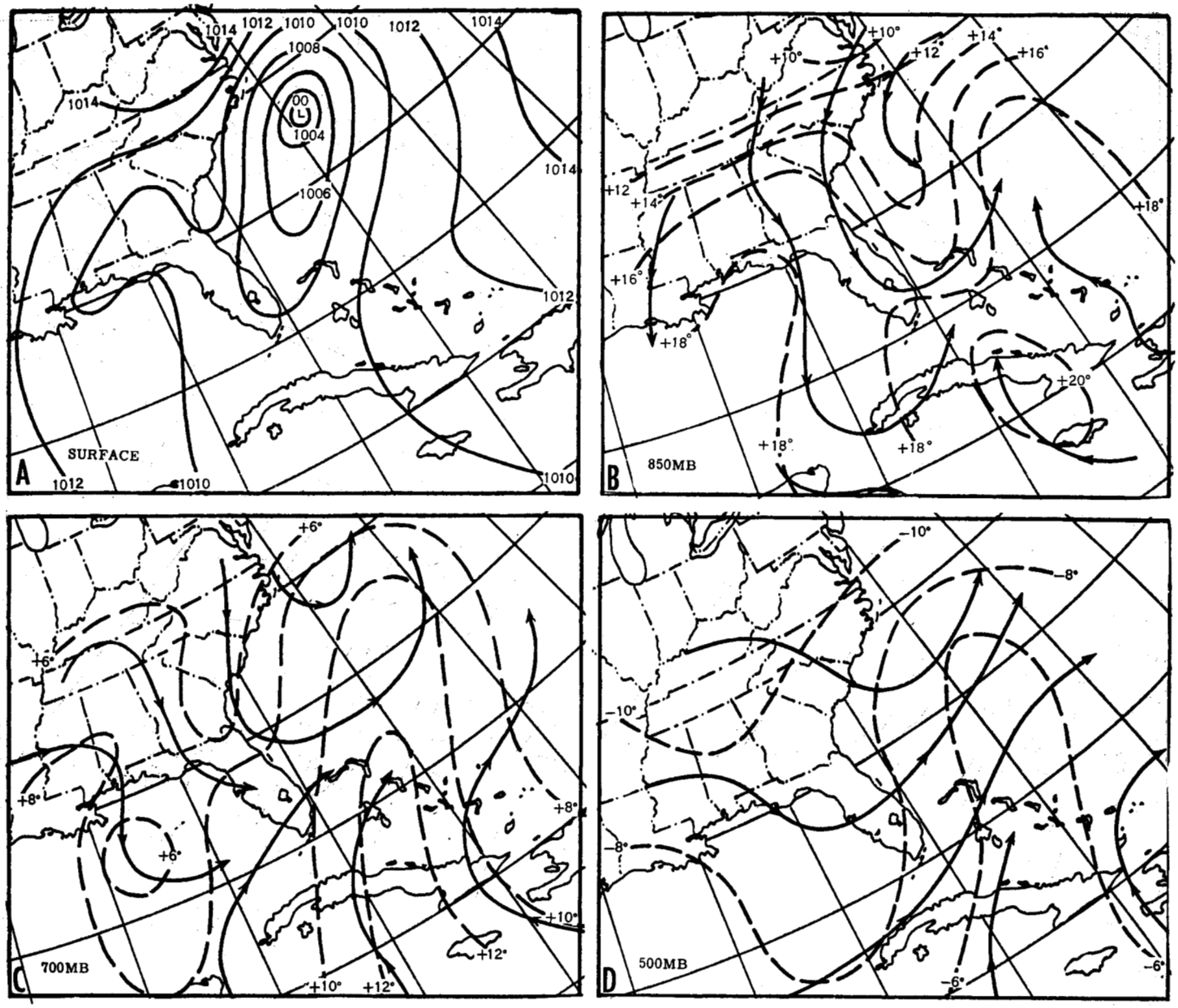

FIGURE 7.—0000 GMT, May 27, 1958. (A) Surface pressure, (B), (C), and (D) streamlines and isotherms at 850, 700, and 500 mb., respectively.

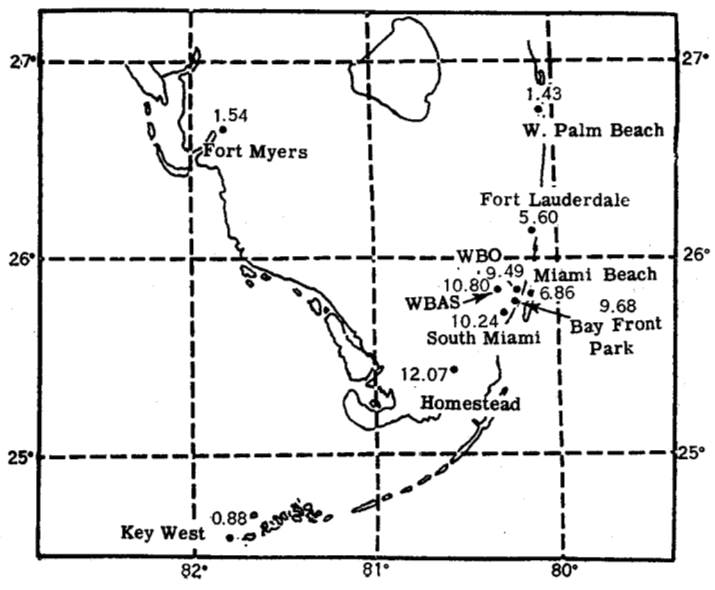

FIGURE 8.—Total amount of rainfall (inches) over central and southern Florida during the depression's passage.

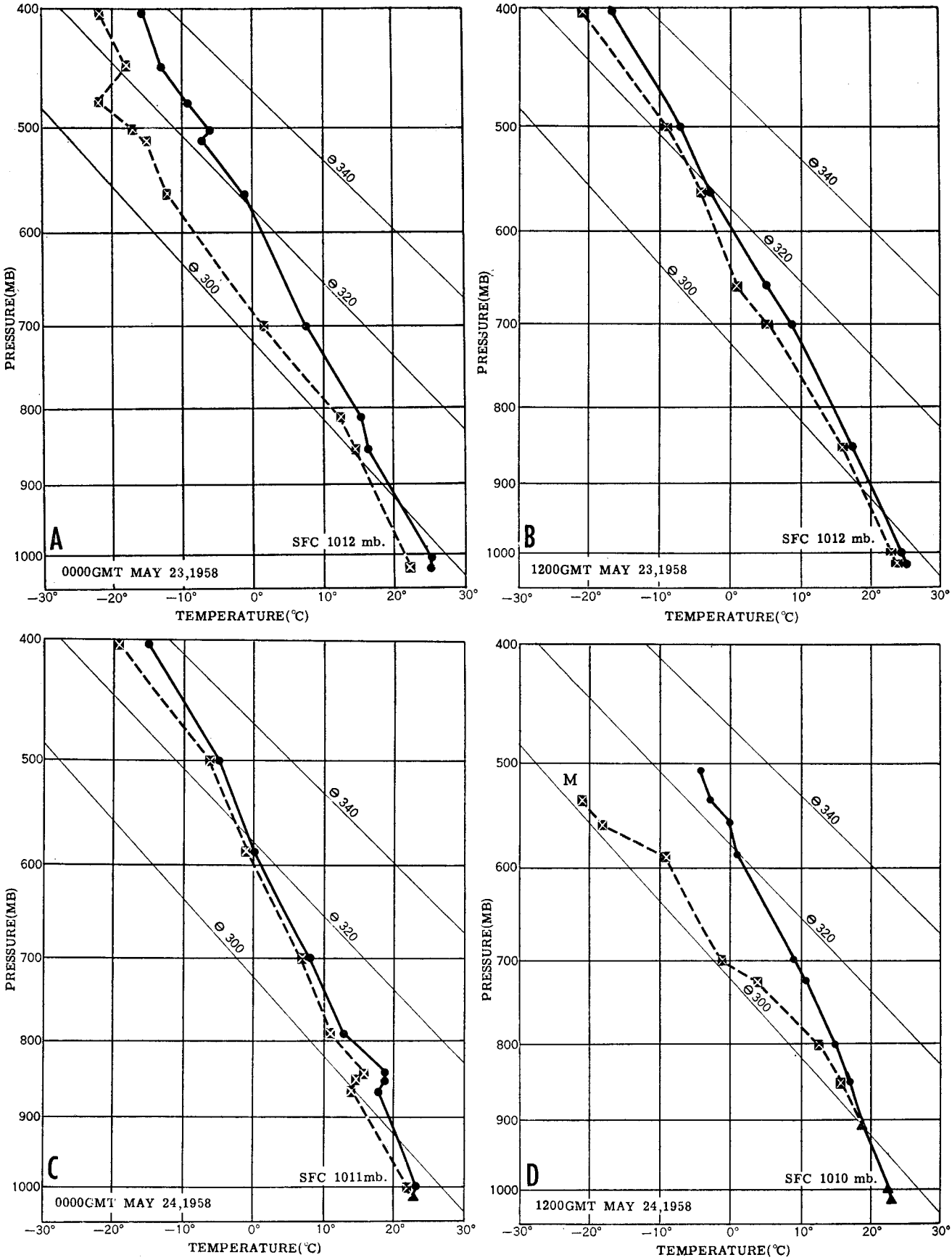

FIGURE 9.—Raob soundings for Miami for May 23–24, 1958 (solid lines=temperature, dashed lines=dew point). They show the large amount of moisture present in the atmosphere during the period of heavy rain. (A) 0000 GMT, May 23, (B) 1200 GMT, May 23, (C) 0000 GMT, May 24, and (D) 1200 GMT, May 24.

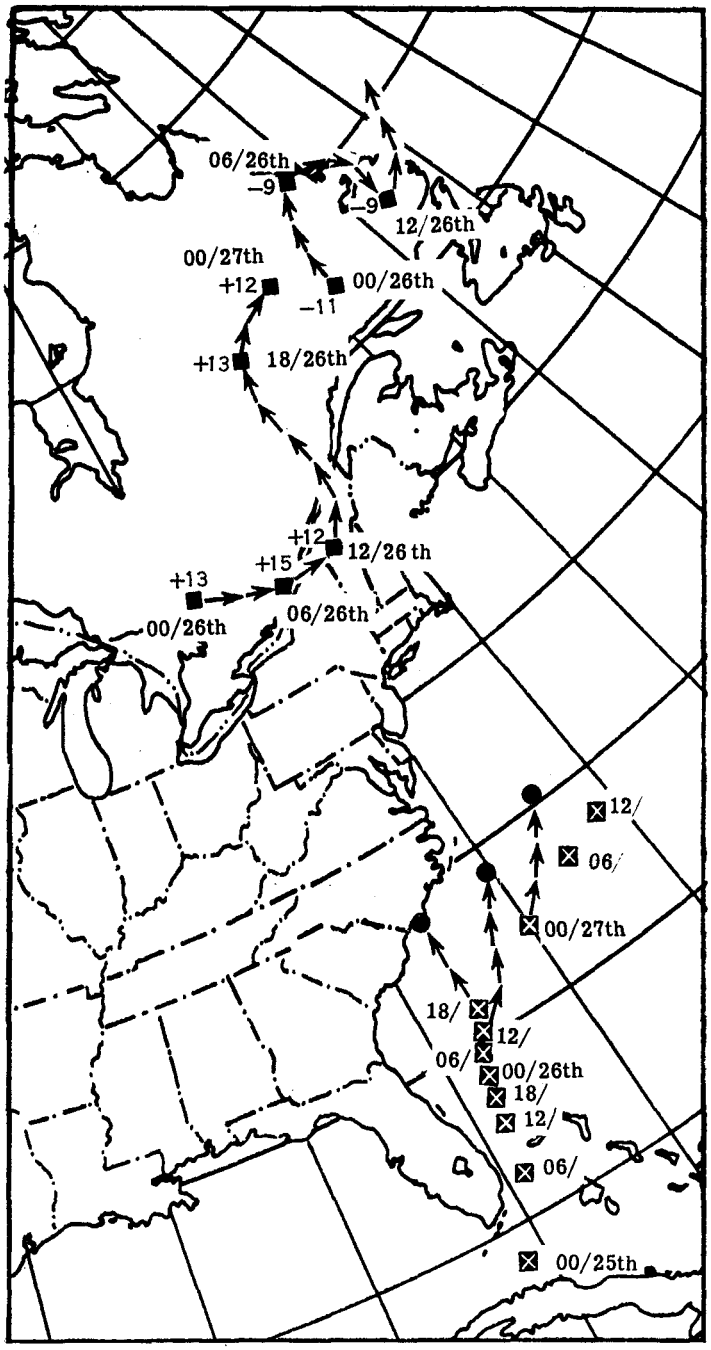

FIGURE 10.—Comparison of the track of the storm and centers of 12-hour surface pressure changes with the forecast positions of the Low. X is position of Low. ● (dot) is forecast position of Low. ■ (square) indicates the center of the 12-hour surface pressure change.

did not occur. What happened to spoil the forecasts was that the High and the 12-hour pressure rises moved so rapidly eastward, merging with the High over the Atlantic, that the Low was never deflected from its northeasterly course.

The Low barely brushed the coast. However, it still contained a large amount of moisture; Hatteras received 3 inches and Nantucket received 1 to 2 inches. Only these two exposed locations had fairly large rainfalls, and the forecast of heavy rain for the entire coastal area failed to materialize.

In favor of the forecast tool used by the District Forecaster, we should mention that his rule did aid him later on to forecast the turn to the north and the acceleration of the system on May 29. Using this rule with the 12-hour pressure *rises* ahead and to the right of the storm path, and the 12-hour pressure *falls* ahead and to the left of the path, the storm was forecast to increase in speed (fig. 12).

7. LOW BECOMES EXTRA-TROPICAL

It has been described how the Low formed in an area of warm surface water. Figure 11 shows that the depression continued to have a warm core through 0000 GMT, May 27. At 0000 GMT, May 28, the Nantucket, Mass., sounding and pibal showed cold advection, and at this time a closed circulation appeared east of Nantucket. The injection of cold air formed a Low aloft giving a northerly slope to the Low's axis. At the same time the isotherms at 500 mb. showed that the warm air veered to the east as the surface Low apparently became associated with the front. The 1000–500-mb. thickness continued to show warm thickness values over the surface Low position but a strong cold tongue, as reflected by the 1000–500-mb. thickness, was advancing southeastward around the warm tongue. This cold air was associated with the next frontal system. Eventually the former depression merged with the next Low and continued on its northerly track.

8. SUMMARY

This Low, which originated as a subtropical depression, had the potentialities of becoming a hurricane. For some unknown reason this development never happened. The depression, in its course, dropped heavy amounts of rain in the Miami area. This rain occurred in an area of convergence and curvature with an unlimited source of moisture.

The depression had a track over the tongue of warm surface water temperatures. Using the rule that hurricanes follow the stream of warm water, the track of this system could have been forecast while it still had hurricane characteristics.

The forecast tool making use of the 12-hour pressure changes (fig. 12) was useful in this case but, like most forecast tools, did not provide a complete answer to the forecasting problem.

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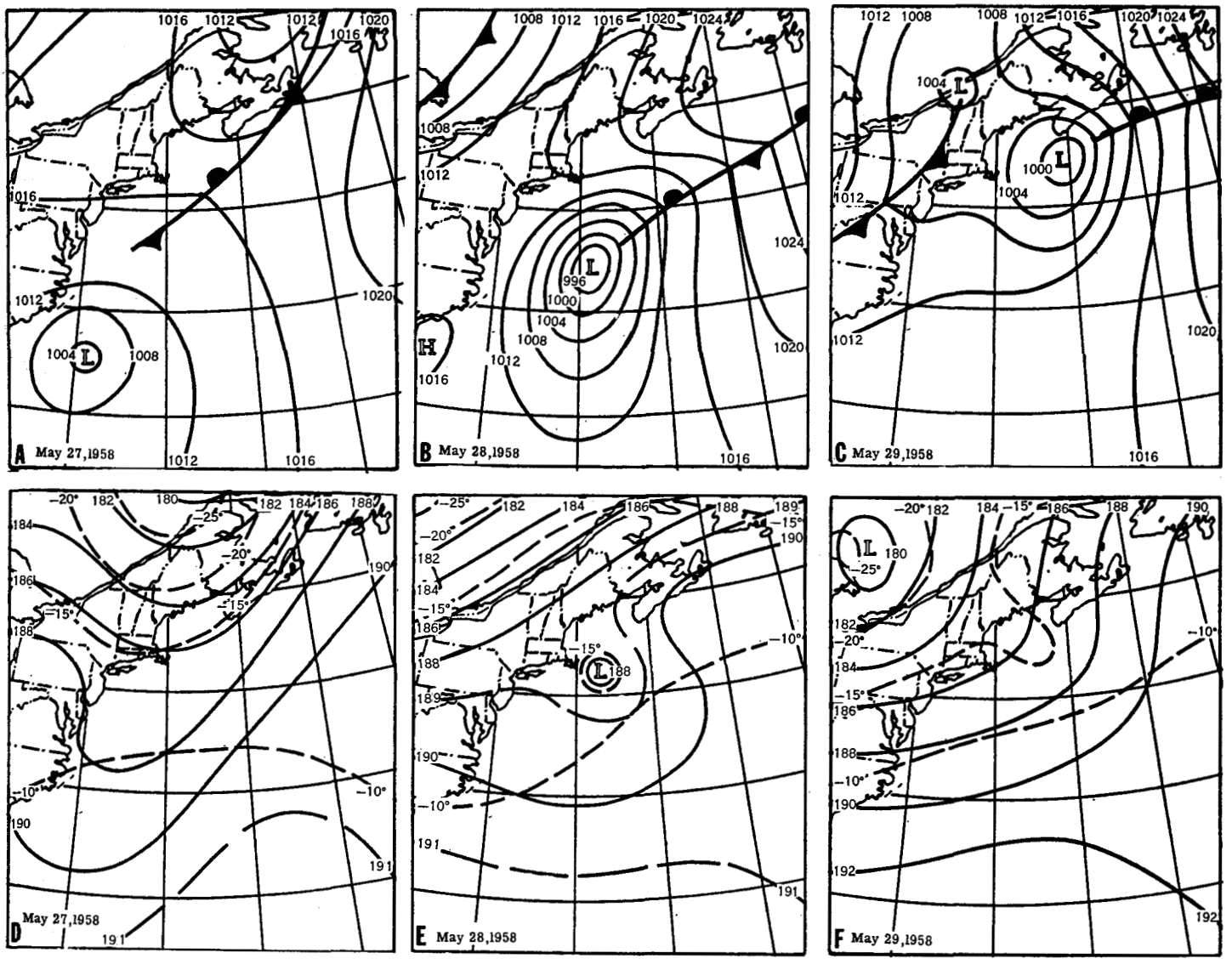

FIGURE 11.—Surface and 500-mb. analyses for 0000 GMT, May 27–29, showing the depression becoming extra-tropical. A, B, and C are surface analyses; D, E, and F are 500-mb. analyses.

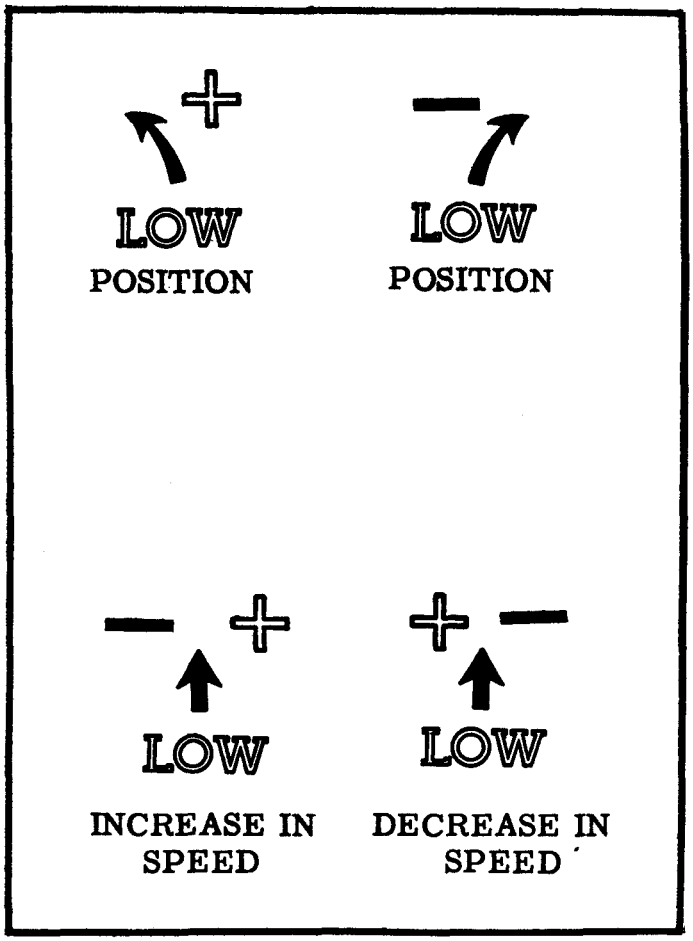

FIGURE 12.—Forecast rules using 12-hour surface pressure changes.

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We especially wish to thank Mr. Gordon Dean of NHRP for his description of the origin of the depression.

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